



**NATIONAL
GEOGRAPHIC**

shorts

DOGS



**A Short
History
From
Wolf to
Woof**

VISIT...

LANZAROTE
Caliente.COM

Dogs

A Short History From
Wolf to Woof



Published by the National Geographic Society
1145 17th Street N.W., Washington, D.C. 20036

Copyright © 2013 National Geographic Society.

“What Dogs Tell Us: The ABC’s of DNA” (NGM, Feb. 2012) copyright © 2012 Evan Ratliff.
“From Wolf to Woof: the Evolution of Dogs” (NGM, Jan. 2002) copyright © 2002 Angus
Phillips. “The Forever Dog” (NGM, Feb. 2012) copyright © 2012 Evan Ratliff. All rights
reserved. Reproduction of the whole or any part of the contents without written permission
from the publisher is prohibited.

eISBN: 978-1-4262-1046-4



The National Geographic Society is one of the world’s largest nonprofit scientific and educational organizations. Founded in 1888 to “increase and diffuse geographic knowledge,” the Society’s mission is to inspire people to care about the planet. It reaches more than 400 million people worldwide each month through its official journal, *National Geographic*, and other magazines; National Geographic Channel; television documentaries; music; radio; films; books; DVDs; maps; exhibitions; live events; school publishing programs; interactive media; and merchandise. National Geographic has funded more than 10,000 scientific research, conservation and exploration projects and supports an education program promoting geographic literacy.

For more information, visit www.nationalgeographic.com

National Geographic Society
1145 17th Street N.W.
Washington, D.C. 20036-4688 U.S.A.

For rights or permissions inquiries, please contact National Geographic Books Subsidiary
Rights: ngbookrights@ngs.org

Cover: Less than 14,000 years separates Koda, the wolf—the dog’s ancestor—and Simon, the Maltese, one of about 400 breeds of today’s *Canis familiaris*. Dogs, tamable and trainable, evolved from wild canids into the first domesticated animal. At the molecular level, not much has changed though; wolves and dogs share a nearly identical DNA makeup. (Robert Clark/NG Image Collection)

v3.1

CONTENTS

Cover

Title Page

Copyright

WOLF TO WOOF: THE EVOLUTION OF DOGS

By Angus Phillips

Photo Insert

NEW TRICKS FROM OLD DOGS

By Evan Ratliff

Photo Insert

THE FOREVER DOG

By Evan Ratliff



Cocker spaniel Jess and owner Janice Gorman play a game of fetch during an evening stroll on New Zealand's Piha Beach. Faithful companions, dogs evolved in the company of humans; their bones share graves with those of

Homo sapiens as far back as 12,000 years ago.

(Chris Gorman/National Geographic My Shot)

Wolf to Woof: The Evolution of Dogs

By Angus Phillips

Roddy MacDiarmid, 57, lifelong shepherd and son of a shepherd, surveys the Scottish Highlands from a ridge overlooking Loch Fyne and the little valley town of Cairndow. On one hand lies the estate of John Noble, where MacDiarmid has worked much of his life; on the other, the estate of the Duke of Argyll. Black-faced lambs and ewes by the hundreds dot the green hillsides below. His border collies, Mirk and Dot, trot faithfully behind. It's familiar turf.

"Everywhere you see," says MacDiarmid, sweeping his shepherd's crook in an all-encompassing arc, "I have gathered sheep. And I can tell you this: You cannot gather sheep from these hills without dogs. Never could and never will; never, never, ever!"

That ringing endorsement is a comfort to those of us who keep dogs but sometimes wonder why. It's good to know that somewhere dogs remain absolutely, undeniably essential to man's work while we happily wander about with our furry friends, feeding them, walking them, scooping their droppings, showering them with affection, and taking them to the vet at the first glimmer of trouble. We occasionally get nipped or barked at in return, but more frequently we are rewarded with a lick on the hand or a wagging tail or a rapt willingness to listen to our most banal statements, as if they are something profound.

Dogs and people, people and dogs: It's a love story so old that no one knows how it started. "The human beings who participated in the earliest domestic relationships [with dogs] thousands of years ago are all dead," says zooarchaeologist Darcy F. Morey with

refreshing candor. “They cannot tell us what was in their minds or what they sought to accomplish.”

And because no one had yet begun to write things down, we are left to speculate, as did the British writer Rudyard Kipling in 1912, when he offered this theory in *Just So Stories*:

Then the Woman picked up a roasted mutton-bone and threw it to Wild Dog, and said, “Wild Thing out of the Wild Woods, taste and try.” Wild Dog gnawed the bone, and it was more delicious than anything he had ever tasted, and he said, “O my Enemy and Wife of my Enemy, give me another.”

The Woman said, “Wild Thing out of the Wild Woods, help my Man to hunt through the day and guard this Cave at night, and I will give you as many roast bones as you need.”

That scenario (minus the talking dog, of which there are, of course, none even today) would have played out about 14,000 years ago if you follow the archaeological trail to the origins of dogs, much further back if you favor DNA evidence suggesting dogs existed well before the earliest traces of their bones. Either way, this is clear: Dogs are not just our proverbial best friends in the animal world but are probably our oldest friends. They evolved from wolves long ago, found a home alongside humans before history makes a record, and never left.

And why would they? Dogs profited handsomely from the association. As wolves—their closest kin—dwindled to scarcity, the sociable, hardworking, malleable, adaptable, lovable dogs in myriad shapes and sizes proliferated alongside humans in the globe’s every corner. Today there are about 68 million in the United States alone, one for every four people. And although a few still work for their daily cup of kibble, most get free rides. “Ninety-nine point nine percent of them do nothing but lie around the house, bark, and eat,” says contemporary writer Stephen Budiansky, grossly overstating the case to make a point. His book, *The Truth About Dogs*, suggests dogs get a lot more from the relationship than humans get back.

Well, they certainly aren't chewing many leftover mutton bones anymore. In her Park Avenue apartment on New York's Upper East Side, NancyJane Loewy feeds Tiffy, her fluffy, eight-pound Maltese, twice a day from an enviable larder. Along with her dog food, says Loewy, "I'll give her a little chicken for breakfast, some steamed baby carrots, steamed broccoli, and some sweet potato—a balanced diet. For dinner, I might add lamb or steak or poached salmon or tuna with steamed vegetables. And for dessert, some low-fat yogurt with no sugar, maybe just a teaspoon of strawberry or apricot yogurt to sweeten it ... Then I'll give her one or two Teddy Grahams, she likes those, and maybe some Pepperidge Farm Goldfish crackers for snacks."

Loewy, whose husband is an investment adviser and whose two sons are away at school, has the time and wherewithal to treat Tiffy as she might royalty, and delights in doing so. "I want to give her the healthiest, most wonderful life possible for as long as possible," says the slender New Yorker as the fluff-ball curls up alongside.

To that end, Tiffy has a professional walker to take her to Central Park daily, is shampooed and groomed once every few weeks at Karen's, a pet emporium on Lexington Avenue, and belongs to a leashless and cageless indoor Manhattan dog club and day care facility, Biscuits and Bath, where she can go for a few hours to exercise with peers under an attendant's eye.

Tiffy has a boyfriend, Bucky, who lives a few blocks away. "He's a handsome, fabulous male, and she's a beautiful, sensitive female," says Loewy of the happy canine couple. "We get together at least once a week for play days. Sometimes we go to the Stanhope Hotel for lunch," on a terrace where pets are permitted, "or we go to Bistro du Nord on 93rd Street and share a cheese and fruit plate with the dogs."

Not all today's dogs are as pampered, of course. Billy Dodson, huntsman for the Thornton Hill Hounds near Sperryville, Virginia, keeps a pack of 90 mostly Penn-Marydel foxhounds in an old cattle barn and fenced yard in the shadow of the Blue Ridge Mountains, where the hounds sleep rough in unpainted wooden barracks and live on a spartan diet. Dodson, who has worked with hounds for 40

of his 55 years, assembled the pack over a two-year span and “never paid anything for any of them,” instead accepting donations and trades from other huntsmen, as is the custom in the foxhunting world. He subsequently crossbred some Penn-Marydels with American foxhounds to create his own unique subtype.

Dodson has a name for each of his charges and can pick them all out on sight, though they look much alike to the unpracticed eye. He can even identify them by voice. As we stand outside the barn one bright spring morning, a dog barks. “Shut up, Sarge,” shouts Dodson, adding in an aside, “I won’t keep a mouthy hound.” Sarge, wherever he is behind those walls, dutifully pipes down.

Dodson takes pride in feeding his dogs for just a dollar a week apiece, though he sometimes has to boost rations in winter, and it gets costlier. Once a day, the ravenous, 60-pound hounds devour a heap of fatty scraps from an abattoir that processes buffalo meat, and Dodson augments the scraps with dry food he buys wholesale in 50-gallon drums.

As doted on as Tiffy is, she seems neither more content nor more fit than any of the hounds, by contrast. During the hunting season from August to March, the hounds get to chase after foxes through dappled woods and fields three times a week with horseback riders in keen pursuit, and they are exercised twice a week in the off-season. They are lean athletes that take confinement in stride, waiting for the next chance to run.

I tag along for an exercise session with Dodson, who brings whippers-in to keep the hounds in check. A walk with his pack is as much an exercise in discipline as a physical exercise. The whippers-in snap their leather at dawdlers to keep the pack tight and focused on the huntsman, who looks every bit the Pied Piper in overalls, with his horn and bag of kibble.

The whippers-in are Dave Ingram, a retired banker from Culpeper, and Beth Opitz, a housewife, foxhunter, mother, and hound lover from Berryville, who drives a couple of hours round-trip twice a week to help Dodson. Ingram says listening to the hounds chase a fox along a ridgetop on an autumn day “makes the hair stand up on the back of my neck.” Opitz, who grew up with a pack of hounds

her veterinarian father still keeps in Pennsylvania, loves foxhunting so much, she says, "If I got a second life and could choose how to live it, I'd live it as a hound." Short of that, she keeps a pack of 17 beagles in a pen behind her house and uses them to chase rabbits twice a week with her husband and two children.

If Loewy, Dodson, and Opitz seem extreme in their affection for dogs, they are hardly alone. Dogs are kept in 40 million U.S. homes these days, and Americans spend billions of dollars a year on dog food and dog health care. What then of this abiding affection of humans for dogs, and dogs of all stripes for humans? How and why did it start?

Genetic studies show that dogs evolved from wolves and remain as similar to the creatures from which they came as humans with different physical characteristics are to each other, which is to say they are not much different at all. "Even in the most changeable mitochondrial DNA markers [DNA handed down on the mother's side], dogs and wolves differ by not much more than one percent," says Robert Wayne, a geneticist at the University of California at Los Angeles.

Wolflike species go back one to two million years, says Wayne, whose genetic work suggests dogs of some sort began breaking away about 100,000 years ago. Wolf and early human fossils have been found close together from as far back as 400,000 years ago, but dog and human fossils date back only about 14,000 years, all of which puts wolves and/or dogs in the company of man or his progenitors before the development of farming and permanent human settlements, at a time when both species survived on what they could scratch out hunting or scavenging.

Why would these competitors cooperate? The answer probably lies in the similar social structure and size of wolf packs and early human clans, the compatibility of their hunting objectives and range, and the willingness of humans to accept into camp the most suppliant wolves, the young or less threatening ones.

Speculators suspect, as Kipling did, that certain wolves or protodogs worked their way close to the fire ring after smelling something good to eat, then into early human gatherings by proving

helpful or unthreatening. As packs of 25 or 30 wolves and clans of like-numbered nomadic humans roamed the landscape in tandem, hunting big game, the animals hung around campsites scavenging leftovers, and the humans might have keyed off the wolves, with their superior scenting ability and speed, to locate and track prospective kills. At night, wolves with their keen senses could warn humans of danger approaching.

Times might not have been as hard back then as is commonly thought. In many instances, food would have been plentiful, predators few, and the boundaries between humans and wildlife porous.

Through those pores and into our hearts slipped smaller or less threatening wolves, which from living in packs where alpha bosses reigned would know the tricks of subservience and could adapt to humans in charge. Puppies in particular would be hard to resist, as they are today. Thus was a union born and a process of domestication begun.

Over the millennia, admission of certain wolves and protodogs into human camps, and exclusion of larger, more threatening ones led to development of people-friendly breeds distinguishable from wolves by size, shape, coat, ears, and markings. Dogs were generally smaller than wolves, their snouts proportionally reduced. They would assist in the hunt, clean up camp by eating garbage, warn of danger, keep humans warm, and serve as food. Native Americans—among others—ate puppies, and in some societies, it remains accepted practice.

By the fourth millennium B.C., Egyptian rock and pottery drawings show hounds hunting with men, driving game into nets. Then, as now, the relationship was not without drawbacks. Feral dogs roamed city streets, stealing food from people returning from market.

Thousands of years later, dogs still can be trouble. From 1979 to 1998, more than 300 people in the United States were killed in dog attacks. Most were children. In 1994, the last year data were compiled, an estimated 4.7 million Americans were bitten, 6,000 of

them hospitalized. Despite their penchant for misbehavior, and sometimes because of it, dogs keep turning up at all the important junctures in human history.

In ancient Greece, 350 years before Christ, Aristotle described three types of domesticated dogs, including speedy Laconians used by the rich to chase and kill rabbits and deer. Three hundred years later, Roman warriors trained large dogs for battle. The brutes could knock an armed man from his horse and dismember him.

Dogs won few friends in the Dark Ages, when they scavenged corpses of plague victims, but they were much in favor by the second millennium, chasing rabbits and stags for British royalty. In 17th-century England dogs still worked, pulling carts, sleds, and plows; herding livestock; or working as turnspits, powering wheels that turned beef and venison roasts over open fires. But working dogs were not much loved and were usually hanged or drowned when they got old.

Meanwhile, “unnecessary” dogs gained status among royalty. King James I was said to love his dogs more than his subjects; Charles II was famous for playing with his dog at Council table; and his brother James had dogs at sea in 1682, when his ship was caught in a storm. As sailors drowned, he allegedly cried out, “Save the dogs and Colonel Churchill!”

By the late 19th century, the passion for breeding led to creation of private registries to protect prized bloodlines. The Kennel Club was formed in England in 1873, and the American Kennel Club (AKC) was founded across the Atlantic 11 years later. Today, the AKC registers 150 breeds, the Kennel Club lists 196, and the Europe-based Federation Cynologique Internationale recognizes many more. Dog shows sprouted in the mid-1800s, when unnecessary dogs began to vastly outnumber working ones, as they do to this day, unless you count companionship as a job.

And many do. In a recent survey of U.S. dog owners, 94 percent listed companionship as a key benefit, while only 6 percent hunted with dogs and 4 percent used them in farming.

People find ways to keep dogs even under the toughest conditions. In New York City, almost 100,000 are registered, and

officials believe unregistered dogs outnumber those three to one, putting the total at roughly 400,000. Caring for a dog in a city where apartments are tiny, streets and sidewalks are packed, and indoor and outdoor space is scarce is a challenge, but New Yorkers rise to it.

In Central Park, regulations that require dogs to be leashed are unenforced from 9 p.m. to 9 a.m., giving dogs and masters a chance to run free on dewy hillsides under tall trees. Patrice Bertin, who restores fine artwork for a living, takes his basenji named Filou (it means “naughty” in French) to a hillside behind the Metropolitan Museum of Art every morning, where Filou runs in a large and astonishingly varied crowd ranging from birdlike miniature Doberman pinschers to towering Great Danes.

How do you maintain a brace of Great Danes in New York? I shout the query to their owner, running along to keep up with them. “Separate apartment,” he shouts back with a crooked grin. “Two saddles!”

Bertin, who likes having Filou underfoot during solitary working days, and his fellow owners chat amiably as the dogs romp. Most are women. “It’s our breakfast social club,” says Letitia Corcoran, a self-proclaimed “burned-out real estate agent” who once accumulated three dogs and twelve cats in her apartment, all rescued from shelters where they awaited euthanasia. She got in such trouble with her landlord that she was threatened with eviction. “I fought for them!” she says.

Some dog lovers worry that city life and preoccupation with pedigree lead to dogs’ being bred for looks rather than talent and to a general decline in their health and usefulness. It may be true, but dogs have not lost their most remarkable natural sense, smell, boosted by as many as 220 million olfactory receptors. (Humans have five to ten million.) My own background is with bird-hunting dogs, which continue to amaze the initiated and uninitiated with their ability to find game or anything else with even the faintest odor.

For reassurance that this skill hasn’t been lost, I stop by the tiny town of Goldvein, Virginia, to see Jack Jagoda, co-founder and

president of the North American Hunting Retriever Association. His best dog, Elvis, a yellow Labrador, lives in the house and sleeps on the bed, but turn Elvis loose in the field and he is transformed to higher purpose.

Jagoda drives to a hillside behind his kennels and leaves Elvis in the truck while we hike down a rutted track to a wooded creek. We cross it, go up the far bank, and walk to where the creek opens into a pond. Jagoda treks uphill and tosses a plastic training dummy the shape of a cucumber into a pile of leaves. We go back and fetch Elvis, who shakes the sleep from his eyes, relieves himself a few times, and comes to heel. Jagoda calms him, points a hand toward the training dummy some 250 yards away. The view is obscured, but when Jagoda barks “Elvis!” the dog is away.

Jagoda whistles him to a stop halfway down the hill, casts him right with a wave to circumvent a brush pile, and then stops him at water’s edge to reset the course. The Lab plows in, stops midway across to be redirected at an angle that puts him ashore downwind of the dummy. He romps out of the water, never stops to shake, runs by the dummy, comes back on command and catches its scent from several yards away, snuffles it from the shrubs, and races back to turn it over.

A half hour later, he’s collapsed across my feet in the living room as Jagoda sings his praises. “He doesn’t conform to breed standards,” says Jagoda. “He’s too big.” Keepers of pedigree registries “would say that technically he’s not even a Lab and shouldn’t be bred. Isn’t that ridiculous! He’s a grand master hunter and makes more money than most people do. I get \$500 for stud fee and breed him twice a week!”

Pedigreed also-rans serve other worthy functions. I spent time with Lori O’Heron Rizzo, who lives in the Maryland suburbs outside Washington, D.C., with her husband, two sons, and service dog, Banjo, a black Labrador donated to and trained by the nonprofit Fidos For Freedom. Rizzo, 43, is a freelance graphic artist whose severe rheumatoid arthritis led to removal of one hip, one knee, and a shoulder. She spent three years on morphine just to cope with the pain but is better now and gets around in an electric wheelchair.

With kids Eric and Patric in school and husband Tony at work, she found home a nerve-racking place. If she fell, she couldn't get up; if she dropped something, she couldn't pick it up. Now gentle Banjo follows her, sleeps at her feet, and rides with her in a specially equipped van. "He does a lot of picking up," she says. "Keys, tissues—whatever I drop. With his harness on, I can get myself up and walk, using him for balance. I'm happier with him, more confident, and not so afraid of what's in the future."

Out at the U.S. Customs training center for drug- and currency-sniffing dogs in Front Royal, Virginia, handlers fine-tune the noses of 85 recruits a year, mostly retrievers rescued from shelters. "Any place you can hide drugs, smugglers will find a way to," says agent Jeff Gabel, a strapping Chicagoan who started working with German shepherds in the Army more than 20 years ago and has been a canine specialist since. "These dogs find drugs inside propane tanks, in false-sided suitcases covered with fiberglass and Bondo, inside the wheels on roller suitcases, in driveshafts and oil pans on cars."

But in these technological times, couldn't a machine detect the odors? "I'm a dog man," says Gabel. "To say a machine is ever going to catch up to a dog's nose, it's unlikely."

"A machine has to be calibrated, directed at a target," says Carl Newcombe, former director of the center. "A dog responds outside the parameters. He smells it wherever it is and responds. Half the time, we're not even in search mode when the dog finds something."

Dogs have been trained to find land mines in war zones, sniff out survivors after earthquakes or bombings, and locate drowning victims underwater. They serve as eyes for the blind, ears for the deaf, and therapeutic companions to the unwell. They can detect signs of an epileptic fit before the sufferer knows it's coming. They find quail, ducks, grouse, and woodcock for sportsmen, and they defend the dwellings of worried urbanites in bad neighborhoods.

But truth be told, dogs that work today are a minority, awash in a sea of village scavengers and those that make their way through life just being bits of fluff or bundles of fur to cuddle. Nowhere is that more evident than at the world's biggest dog show, Crufts, in England.

Named for a 19th-century itinerant dog food salesman and entrepreneur who never owned dogs himself, Crufts drew 20,780 dog entries and some 88,000 people to the 2001 show, which covered 250,000 square feet in five huge halls at the National Exhibition Centre in Birmingham. Far from being a gathering of tony toffs in tweed, it's a convention that crosses every social barrier, with competitors like tattooed, earringed, crew-cut Marc Howard, who came to show Ice, his burly Chinese shar-pei, and proper ladies like Sue Pinkerton of Exeter, who shows Tcheria Hot in the Shade, a towering borzoi descended from the darlings of Russian royalty.

"It's called competing in breed, but really it's a beauty show," says Caroline Kisko, a Crufts spokesperson who herself keeps 21 Siberian huskies and four German shepherds (she races the huskies from a wagon, sled dog-style). "It's good fun, and the dogs love it," she says of Crufts. "Thousands of people are there all day petting them; the dogs go home exhausted because normally they sleep all day."

A roam around Crufts tires the feet as you make your way from show ring to show ring, navigating a seemingly endless trail of canine merchandise displays leading to green swaths of fake grass where Yorkshire terriers, English sheepdogs, puffy bichons frises, dark Gordon setters, feisty wirehaired dachshunds, rottweilers, hairless Chinese crested, and more than 150 other breeds strut and preen for the judges.

The trek starts me wondering how such an array of sizes and shapes, from Chihuahuas you can hold in your hand to hairy mastiffs two men cannot budge, could evolve in the relatively short time since domestication began. If human beings mirrored the size range of dogs, the smallest of us might weigh 20 pounds and the largest a ton. How did dogs get so diverse?

Jeff Sampson, a molecular geneticist and the Kennel Club's genetics coordinator, reckons that, because dogs have lots of chromosomes (78 to a human's 46), the opportunity to mix and match is enhanced. Man has been the great mixer and matcher. "Breeds haven't evolved; breeders have just selected for certain

features. In the past 300 or 400 years, they could ruthlessly select for features they wanted and very quickly get them,” says Sampson.

By way of example, he offers the work of a friend, Bruce Cattanach, a fellow geneticist who studies mice professionally but shows boxers for a hobby. “Boxers are supposed to have docked tails,” says Sampson, “but veterinarians don’t like to do that sort of cosmetic surgery anymore, so Bruce decided to try to breed a tailless boxer.”

It didn’t take long. To get his wish, Cattanach crossed a boxer with a tailless Welsh corgi, and then took the tailless offspring that looked most like a boxer and mated it to other boxers. Eight years and four generations later, he had natural tailless boxers winning competitions in the show ring.

“The size difference in dogs is more variable than any other species,” says Cattanach, “and people since the beginning of time have been working hard to select for certain types—big dogs as guards, speedy dogs for hunting, lapdogs for company. To go from a standard poodle to a toy, it’s fairly easily done. But I don’t know of any other species you’d want to do it with. I’m sure you couldn’t do it with mice.”

Such is the remarkable power dog breeders wield. All of which advances the belief that humans really are in charge, which brings us back to the original question: If we’re so smart, why do we work so hard while dogs loll around? Could it be that humans aren’t the cleverest half of this ageless duet after all?

After our long climb in the Scottish Highlands, Roddy MacDiarmid and I stop in a pasture in Glen Fyne so he can show off some of the maneuvers with Mirk and Dot that have won him prizes in sheepdog trials, including the Scottish and British national brace championships. He has the sheepdogs round up a small flock of ewes, hector them around a barrel and across obstacles, bring them to us, circle us, and take them away, all with just a toot here and there on his shepherd’s whistle. It’s quite a show, with the dogs under complete control all the time. Afterward, we load Dot and Mirk into the car, and I treat MacDiarmid to a soda at the local pub, where he talks glowingly of his exceptional dogs.

Then we part, he to walk around the corner to his house in Cairndow, I to go 35 miles down the road to Colintrave, where I'm staying with friends in a cottage overlooking the Isle of Bute. We're pouring a wee dram of Scotch when the phone rings.

"It's Roddy," says my host. "He needs you."

"Is this Angus?" asks the shepherd, sounding drained and concerned. I answer that it is.

"Would you kindly look in the boot of your car?" he asks sheepishly. "I believe I left my dogs there."



Eucyon, a canid the size of a large wolf, attacks a horned herbivore eight million years ago on what is now the American Great Plains. At left, fox-size *Eucyon* converge on a peccary. With a cooling climate, *Eucyon* and their large prey disappeared into extinction. But *Eucyon*, with teeth suitable for eating meat and plants, survived. *Eucyon* species eventually gave rise to *Canis*, the genus that includes today's wolves and dogs. About 800,000 years ago, wolves migrated from Eurasia to today's North American Arctic.

(Art by Mark Hallett/NG Image Collection)



*Three gray wolves, ancestors of today's dog, huddle together during a Quebec snowstorm. Over time, humans transformed the wild canid into the first domesticated animal, *Canis familiaris*—the faithful and tamable dog.*

(Karl UmBriaco/National Geographic My Shot)



About 12,000 years ago, hunter-gatherers placed a woman's body in a grave with her hand cradling a pup. Although it's not known whether the pup was a dog or a wolf, the burial site in what is now Israel provides some of the earliest fossil evidence of the dog's domestication.

(Richard Olsenius/National Geographic Stock)



A group of purebred dogs displays the incredible diversity of their species—from left, a poodle, a Belgian Tervuren, a Maltese, two cocker spaniels, a cavalier King Charles spaniel puppy, two French bulldogs, and a terrier. Variety aside, all dog breeds share certain characteristics born of their common origin, including the ability to be trained, tail wagging, and multicolored coats.

(Cynoclub/Shutterstock)



Professional dog walkers tend to a pack of dogs on a summer day in downtown Washington, D.C. Walking dogs for a living is a growing business, because many people work long hours and don't have time to walk their furry friends.

(Joel Carillet/[iStockphoto.com](https://www.istockphoto.com))



Rescue workers train dogs to walk near fire during a civil defense exercise in Italy. Dogs have been taught to locate land mines in war-torn areas, find victims in earthquake-ravaged cities, sniff out drugs, serve as therapeutic companions, and provide eyesight for the blind.

(amidala76/[Shutterstock.com](https://www.shutterstock.com))



Yorkshire terriers, originally bred to catch rats, pose on velvet-upholstered pedestals during a competition at the world's biggest dog show, Crufts, in England. Today, there is a growing trend among humans to shower more and more affection on their canine friends.

(Richard Olsenius/National Geographic Stock)

New Tricks From Old Dogs

By Evan Ratliff

Scientists have found the secret recipe behind the spectacular variety of dog shapes and sizes, and it could help unravel the complexity of human genetic disease.

It's an unusually balmy mid-February afternoon in New York City, but the lobby of the Hotel Pennsylvania is teeming with fur coats.

The wearers are attendees of what is undoubtedly the world's elite canine mixer, one that takes place each year on the eve of the Westminster Kennel Club dog show. Tomorrow, the nation's top dogs from 173 breeds will compete for glory across the street at Madison Square Garden. But today is more akin to a four-legged meet and greet, as owners shuffle through the check-in line at the competition's official lodgings. A basset hound aims a droopy eye across a luggage cart at a wired-up terrier. A pair of muscled Rhodesian ridgebacks, with matching leather leashes, pause for a brief hello with a fluffy Pyrenean shepherd. Outside the gift shop, a Tibetan mastiff with paws the size of human hands goes nose to nose with a snuffling pug.

The variety on display in the hotel lobby—a dizzying array of body sizes, ear shapes, nose lengths, and barking habits—is what makes dog lovers such obstinate partisans. For reasons both practical and whimsical, man's best friend has been artificially evolved into the most diverse animal on the planet—a staggering achievement, given that most of the 350 to 400 dog breeds in existence have been around for only a couple hundred years. The breeders fast-forwarded the normal pace of evolution by combining traits from disparate dogs and accentuating them by breeding those

offspring with the largest hints of the desired attributes. To create a dog well suited for cornering badgers, for instance, it is thought that German hunters in the 18th and 19th centuries brought together some combination of hounds—the basset, a native of France, being the likely suspect—and terriers, producing a new variation on the theme of dog with stubby legs and a rounded body that enabled it to chase its prey into the mouth of a burrow: hence the dachshund, German for “badger dog.” (A rival, flimsier history of the breed has it dating back, in some form, to ancient Egypt.) Pliable skin served as a defense mechanism, allowing the dog to endure sharp-toothed bites without significant damage. A long and sturdy tail helped hunters to retrieve it from an animal’s lair, badger in its mouth.

The breeders gave no thought, of course, to the fact that while coaxing such weird new dogs into existence, they were also tinkering with the genes that determine canine anatomy in the first place. Scientists since have assumed that underneath the morphological diversity of dogs lay an equivalent amount of genetic diversity. A recent explosion in canine genomic research, however, has led to a surprising, and opposite, conclusion: The vast mosaic of dog shapes, colors, and sizes is decided largely by changes in a mere handful of gene regions. The difference between the dachshund’s diminutive body and the rottweiler’s massive one hangs on the sequence of a single gene. The disparity between the dachshund’s stumpy legs—known officially as disproportionate dwarfism, or chondrodysplasia—and a greyhound’s sleek ones is determined by another one.

The same holds true across every breed and almost every physical trait. In a project called CanMap, a collaboration among Cornell University, University of California in Los Angeles (UCLA), and the National Institutes of Health, researchers gathered DNA from more than 900 dogs representing 80 breeds, as well as from wild canids such as gray wolves and coyotes. They found that body size, hair length, fur type, nose shape, ear positioning, coat color, and the other traits that together define a breed’s appearance are controlled by somewhere in the neighborhood of 50 genetic switches. The difference between floppy and erect ears is determined by a single

gene region in canine chromosome 10, or CFA10. The wrinkled skin of a Chinese shar-pei traces to another region, called HAS2. The patch of ridged fur on Rhodesian ridgebacks? That's from a change in CFA18. Flip a few switches, and your dachshund becomes a Doberman, at least in appearance. Flip again, and your Doberman is a Dalmatian.

"The story that is emerging," says Robert Wayne, a biologist at UCLA, "is that the diversity in domestic dogs derives from a small genetic tool kit."

Media reports about the gene for red hair, alcoholism, or breast cancer give the false impression that most traits are governed by just one or a few genes. In fact, the Tinkertoy genetics of dog morphology is a complete aberration. In nature, a physical trait or disease state is usually the product of a complex interaction of many genes, each one making a fractional contribution. Height in humans, for instance, is determined by the interaction of some 200 gene regions.

So why are dogs so different? The answer, the researchers say, lies in their unusual evolutionary history. Canines were the earliest domesticated animal, a process that started somewhere between 20,000 and 15,000 years ago, most likely when gray wolves began scavenging around human settlements. Dog experts differ on how active a role humans played in the next step, but the relationship eventually became a mutual one, as we began employing dogs for hunting, guarding, and companionship. Sheltered from the survival-of-the-fittest wilderness, those semidomesticated dogs thrived even though they harbored deleterious genetic mutations—stumpy legs, for instance—that would have been weeded out in smaller wild populations.

Thousands of years later, breeders would seize on that diverse raw material when they began creating modern breeds. They tended to grab traits they desired from across multiple breeds—or tried to rapidly replicate mutations in the same one—to get the dog they wanted. They also favored novelty, because the more distinct a line of dogs appeared, the more likely it was to garner official recognition as a new breed. Such artificial selection tended to favor

single genes with a large impact, allowing traits to be fixed more rapidly than groups of smaller-impact genes ever could.

“It’s kind of like when you set your remote control to control your TV, your stereo, and your cable,” says Carlos Bustamante, a CanMap geneticist now at Stanford University. “You hit the on-off switch, and it does them all.”

This revelation has implications the scientists are just beginning to unravel—most important, for the understanding of genetic disorders in humans. Already, more than a hundred dog diseases have been mapped to mutations in particular genes, many of them with human counterparts. Those diseases may have a whole array of mutations leading to a risk of disease in dogs, as they do in us. But because dogs have been genetically segregated into breeds developed from just a few original individuals, each breed has a much smaller set of errant genes—often only one or two—underlying the disease. For instance, Cornell researchers studying the degenerative eye disease retinitis pigmentosa—shared by humans and dogs—found 20 different canine genes causing the disorder. But a different gene was the culprit in schnauzers than in poodles, giving researchers some specific leads for where to start looking in humans. Meanwhile, a recent study of a rare type of epilepsy in dachshunds found what appears to be a unique genetic signature, which could shed new light on the disorder in us as well.

In short, while the Victorian breeders were grafting dogs to suit their tastes, they were also creating genetically isolated populations, little knowing how useful they might be to scientists in the future. The possibilities are especially abundant for cancer, certain types of which can show up as often as 60 percent of the time in some dog breeds but only once in every 10,000 humans.

“We are the people who are doing the genetics,” says Elaine Ostrander, who studies dog evolution and disease at the National Human Genome Research Institute at NIH. “But breeders are the people who have done all the fieldwork.”

One category of trait that has so far proved resistant to the CanMap analysis is behavior. Only a single mutant behavioral gene has been identified to date: the dog version of the gene for

obsessive-compulsive disorder in humans, which can cause Doberman pinschers to obsessively suck on their fur to the point of bleeding. More common characteristics such as loyalty, tenaciousness, or the instinct to herd clearly have genetic underpinnings. But they can also be affected by factors ranging from a dog's nutrition to the presence of children in the house, making them difficult to quantify rigorously enough to study. Nevertheless, "we've probably got as good a shot, if not better, of understanding behavior in dogs over other animals," says Stanford's Bustamante. After all, he points out, there are millions of dog lovers out there willing and eager to help with the fieldwork.

Along with the patchwork of breeds, Manny, an Afghan hound, and Razbery, an English setter, represent the best of the best: entrants in the Westminster Kennel Club's 135th annual dog show. The centuries of breeding that produced such striking diversity also created isolated genetic populations that are helping scientists understand human diseases. "We're the people doing the genetics," says one researcher. "But breeders have done all the fieldwork."

Hundreds of genes interact to produce a physical trait in humans and most mammals. For dog traits, the magic number is usually three or fewer. The type of coat a dog wears depends on three genes. Mutations in these genes create a coat that's long, curly, wiry, or a combination. If none of the three genes are mutated, the dog will have the short, smooth coat of breeds like beagles and basset hounds—and the dog's ancestor, the gray wolf.

Analyzing the DNA of 85 dog breeds, scientists found that genetic similarities clustered them into four broad categories. The groupings reveal how breeders have recombined ancestral stock to create new breeds; a few still carry many wolflike genes. Researchers named the groups for a distinguishing trait in the breeds dominating the clusters, though not every dog necessarily shows that trait.

Wolflike

With roots in Asia, Africa, and the Middle East, these breeds are genetically closest to wolves, suggesting they are the oldest domesticated breeds.

Herders

Familiar herding breeds such as the Shetland sheepdog are joined by breeds never known for herding: the greyhound, pug, and borzoi. This suggests those breeds either were used in the creation of classic herding dogs or descended from them.

Hunters

Most in this group were developed in recent centuries as hunting dogs. Although the pharaoh hound and Ibizan hound are said to descend from dogs seen on ancient Egyptian tombs, their placement here suggests they are re-creations bred to resemble ancient breeds.

Mastiff-like

The German shepherd's appearance in this cluster, anchored by the mastiff, bulldog, and boxer, likely reflects its breeding as a military and police dog.



A giant Great Dane towers over a dainty Chihuahua to display the extremes of dog breeds. Today, nearly 400 different breeds exist, but their DNA remains remarkably similar.

(Erik Lam/Shutterstock)



Scientists have singled out a gene mutation that causes “hairlessness” in dogs like this Chinese crested, which has soft, almost humanlike skin and sports tufts of fur on its paws, tail, and head.

(Elizabeth Hammerschmid/Shutterstock)



Tibetan mastiffs like Midas, a Westminster finalist from Texas, can weigh more than 150 pounds. Originally bred as guard dogs, they remain fiercely protective of their owners.

(Robert Clark/NG Image Collection)



Sidney, a rescue dog, leaps through the air toward his food. Now six, Sidney is still exuberant. “His vertical hasn’t declined much,” says Neely, a Connecticut librarian.
(Jason Neely/National Geographic My Shot)



Oakley, a pug, and Little Dude, a Saint Bernard, illustrate the immense diversity of their species. If men and women displayed as much variety in size, the smallest would measure 2 feet tall and the tallest would be close to 31 feet.

(Robert Clark/NG Image Collection)



For most of their evolutionary history, dogs resembled these half-wild village vagrants that live among the Batammariba in Togo, West Africa. Village mutts, the world's most common kind of dog, eke out an existence in and around human settlements.

(Alida Latham/DanitaDelimont.com)

The Forever Dog

By Evan Ratliff

Labradors may be the most popular breed of dog, but the most populous kind is no breed at all. That distinction goes to the humble village dog scratching out a semiwild living in and around human settlements.

While a postdoc at Cornell University a few years ago, Adam Boyko became curious about the little-studied village vagrants. Though dogs were first domesticated 20,000 to 15,000 years ago, most breeds go back only a few hundred years. Perhaps village dog DNA might shed light on the long, early history of domestication, when canines were hanging around humans yet not under our domain. But how to get samples?

As it happened, around the same time, Boyko's brother Ryan had married, and he and wife Corin were looking for a cheap honeymoon off the beaten track. The three Boykos decided to merge their two quests. Adam—now at Cornell's College of Veterinary Medicine—obtained a grant, then enlisted Ryan and Corin to spend their honeymoon traveling around Egypt, Uganda, and Namibia, befriending villagers and local vets. They collected DNA from more than 300 village dogs.

When the samples were analyzed, most of the village dogs turned out to be as closely related to wolves as they were to fully domesticated dogs. Rather than being mixed-breed mutts that had gone feral in historical times, the village dogs had been eking out an existence on the human fringe for millennia. Their genomes thus reflected a state of early domestication, before artificial selection and inbreeding directed by humans had taken over. "When you are

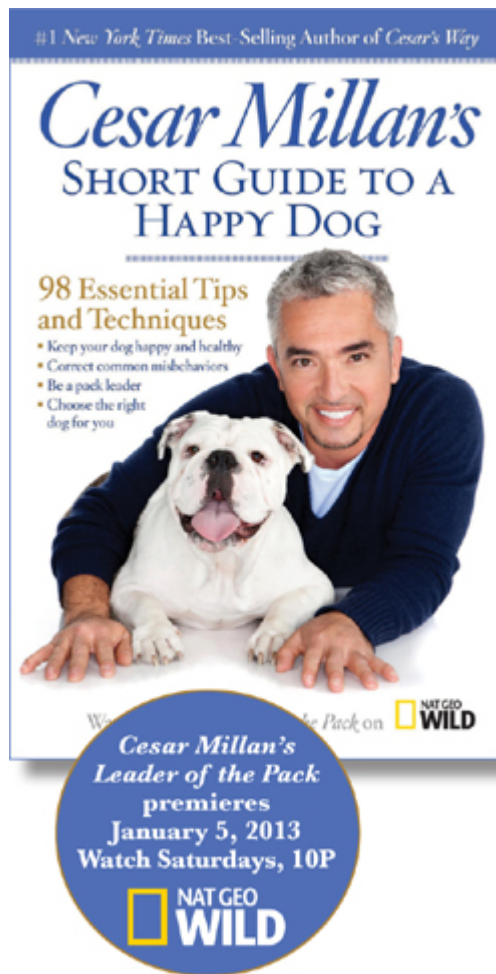
looking at village dogs,” Adam Boyko says, “you have something more akin to natural selection, albeit in an environment that’s managed by humans.”

Unexpectedly, the study also helped to challenge the reigning view on the place where dogs first appeared. Fossil evidence had already pinned the transition from wolf to dog somewhere in Europe or Asia, and a 2002 study had shown that East Asian village dogs were more genetically diverse—an indication that wolves had first been domesticated in East Asia. But the Boykos’ 2009 work found that the African village dogs were just as diverse as the East Asian ones. Some also carried a genetic signature shared with Middle Eastern gray wolves, supporting research by Robert Wayne and Bridgett vonHoldt of UCLA that points to the Middle East as the likely cradle of dogs.

The Boykos continue to expand their sample collection, with another expedition planned for Africa. And they’ve also begun using the same techniques to solve a related mystery: the strange disappearance of native dogs in South America. We know from the historical record that Native Americans had dogs. But previous population surveys in the Americas turned up only dogs with European heritage. “How do you ship so many dogs across the world that they completely replace the native dogs?” Boyko wonders, suspecting that in fact there may still be village dogs with native DNA in the remotest areas of the continent. So in August, the three Boykos packed their bags and headed into the jungles of Peru, searching for the lost American dog.



WHAT WOULD CESAR DO?



In his newest book, **the world's favorite dog behaviorist, Cesar Millan**, shares his hard-earned secrets for keeping your dog healthy and happy. This easy-to-follow guide—written for every caretaker in the family, including kids—goes beyond obedience school basics to offer dog owners valuable lessons on mastering your canine relationship and overcoming common misbehaviors, including how to:

- 🐾 **Read and respond to your dog's body language**
- 🐾 **Exercise, discipline, and reward your dog—in that order**
- 🐾 **Establish rules and boundaries—and enforce them**
- 🐾 **Rock “the walk” ... and more**

Let Cesar unleash the pack leader in you with this inspirational, practical, and essential owner's manual!

Official book of Training Cesar's Way Courses
By New York Times best-selling author and star of
the Emmy-nominated Dog Whisperer with Cesar Millan

 Find news and offers about this book at [Facebook.com/NatGeoBooks](https://www.facebook.com/NatGeoBooks)

Available Wherever Books, EBooks, and Audio Books Are Sold

